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THESIS FOR THE DEGREE OF M.D.
on
OBSERVATIONS ON THE ETIOLOGY OF TROPICAL TYPHOID
by

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In the year 1906, an epidemic of Enteric Fever occurred in Nuwera Eliya, the mountain sanatorium of Ceylon. This Thesis is based on my official report submitted to the Principal Civil Medical Officer, Ceylon, in my capacity as Medical Officer in charge of the Station.

In dealing with the subject of Enteric Fever in the Tropics, both as regards its etiology and prophylaxis, it is, in the first instance, advisable to review the present state of knowledge of the subject, especially in the light of recent Bacteriological research.

The main channels by which enteric is propagated are:-

- (1) Water - either drinking water, or polluted streams used by natives for bathing purposes.
- (2) Milk.
- (3) Food or drink - contaminated by enteric Bacilli conveyed by water, dust, flies, or Typhoid carriers.
- (4) Contact infection, either by direct contact with persons harbouring the bacilli, as in the case of attendants on the sick, and of those in close association in the same room; or indirectly by what is known as Latrine infection.
- (5) Typhoid carriers.

For/

For the elucidation of some of the obscure problems presented by Typhoid Fever epidemics in India, it is further necessary to consider the question of the viability of the Typhoid Bacillus in soil, water, dust and fabrics, and the influence of climatic conditions which favour either the persistence of the bacilli outside the body, or their transmission from infected excreta on the soil to fresh individuals by water, dust or flies. Lastly the question of sewage disposal, the most important factor in the spread of Enteric in India, demands careful consideration.

Notwithstanding the provision of pure water supplies to our Indian Stations, and other sanitary improvements, it is noteworthy that Enteric Fever is as prevalent as ever, and to such an extent as to arouse anxiety and comment in the lay public. In a recent number of the "Spectator"¹ a correspondent writes

"Experience of the past thirty years in this country does not support the optimistic views held as to the power of preventing enteric fever, attained by the discovery of the Bacillus of Eberth. Enteric Fever is more dreaded in India to-day than Cholera, notwithstanding the great improvements in the/

the water supply and sanitation of our cantonments. After twenty-five years of notification, isolation hospitals, disinfection and other preventive measures, Scarlet Fever, Enteric and Diphtheria are more prevalent than ever in most of our great towns. The theory which has prevailed that an infective virus and susceptible people sufficed to produce an epidemic is clearly insufficient. Obviously these diseases favour certain localities, towns, and parts of them and flourish only in certain years. What other conditions favour such epidemics are unknown and indeed unsought for. But just as we are at present not justified in attributing the cessation of an epidemic to precautions which failed to prevent its occurrence, so we are not able to claim the power to prevent these infectious diseases, whether the specific bacillus is known as in the case of enteric or diphtheria, or unknown as in the case of scarlet fever."

WATER. The results obtained by different observers differ, because the conditions under which the experiments were carried out were not the same. Some observers have found that only an insignificant number of bacilli survive a sojourn in water for more than three or four days.

Hoffman/

Hoffman² caused water in an aquarium tank containing fish to be contaminated with Typhoid Bacilli. Despite the presence of many varieties of Protozoa and Saprophytic organisms the Bacillus was isolated from water two months after. The question is summed up in these terms in the article on Typhoid in Osler's system of Medicine. "It is probable that by improved cultural methods our knowledge of the life of the Typhoid Bacillus in water will be increased. The possibility of the multiplication of the bacillus in water is not positively determined."

The difficulty of the isolation of the bacillus from suspected water supplies, by bacteriological methods is well known.

When one considers the habits of the natives it is easy to see that infection may be derived not only by drinking water, but from the streams used for bathing purposes. Bathing, washing of the foulest linen and watering of cattle are carried out at the same spot in the stream, and, to complete the picture, the sight of a native defecating by the side of a stream, in which he performs his "perineal toilet," and completes his ablutions by rinsing his mouth, is not unusual.

THE SOIL IN RELATION TO TYPHOID.

The organisms survive in the soil for weeks or months according to the conditions present at the time. Statements regarding the duration of life of the Bacillus outside the body are most conflicting, some maintaining that the bacillus dies after a short period, others that it survives indefinitely. I agree with those authorities who lay stress on the pollution of the soil as the great source of endemic Typhoid in India. Koch looks upon soil near privies and latrines as a very real danger, especially on account of the ease with which the infective material can be conveyed into houses on the feet of those entering latrines.

Clauditz ³ succeeded in obtaining a strain of Typhoid Bacilli which does not die out when placed in the soil, and it is possible that the bacilli may exist in the soil in some undiscovered form.

Robertson ⁴ in his researches stated that he was able to isolate the bacillus from the soil, after experimental inoculation, 12 months after, in a virulent condition, and held that under certain conditions the bacillus was capable of growing rapidly in certain soils and surviving from one summer to another.

Next/

Next came the experiments of Sidney Martin who found the bacillus alive after 404 days in cultivated soil which had been sterilised. Bacilli added to natural uncultivated soil which had not been sterilised, ceased to exist after 24 hours. He arrived at the conclusion that the Bacillus has only a very short existence in the soil, being destroyed by the products of putrefactive bacteria which exists in most cultivated soils.

Firth and Horrock⁵ prove that the dry earth system offers favourable conditions for the survival for long periods of any specific bacteria which may gain access to the excreta. Their conclusions were that

- (1) There was no evidence that bacilli in the soil could increase or grow in different directions.
- (2) The enteric bacillus was capable of being washed through at least 18 inches of closely packed soil by means of water.
- (3) It survives in moist soils for varying periods, sometimes as long as 74 days, this survival being independent of pollution or the reverse.
- (4) In ordinary soil kept damp with rain water the bacillus could be recovered after 76 days, with dilute raw sewage after 54 days.
- (5) The bacillus disappeared from surface layers after heavy rainfall.

The Imperial Sanitary Commissioner for India in his report for the year 1904, quotes the experiments of Rullman who inoculated

(1) red river sand
(2) sifted vegetable soil
(3) sifted rubbish, and found after a period of six months numerous living bacilli present in all those substances. After 18 months none were found in (1), few in (2) and many in (3), the only change produced by their sojourn in the earth being a diminution in agglutinability.

The results of Houston's ⁶ experiments go to shew that pathogenic organisms such as Typhoid do not maintain their vitality in surface layers of soil for more than a brief period. The most recent researches into the vitality of the Bacillus in soil are those of Mair ⁷ of Dublin who arrived at the conclusion that the Typhoid Bacillus can survive in natural soil in large numbers for about 20 days, and is still present in a living condition after 70 to 80 days. He holds that there is no evidence that the bacillus is capable of multiplying and leading a saprophytic existence in ordinary soil, and that soil organisms have not, as has been supposed by Martin, an antagonistic action towards a Typhoid Bacillus.

Dr./

Dr. Theodore Thomson⁸ of Chichester comes to the provisional conclusion that the soil of that place "may possibly play a part in fostering the vitality and morbid power of the infective material of enteric fever."

As Newman says in his "Bacteriology and Public Health" "more work is required before the microbiology of the soil can be said to be complete or intelligible. Further knowledge of the fact which the soil plays in the culture and propagation of bacteria may suffice to modify many views in preventive medicine."

DUST, it is acknowledged in another medium through which infection is carried.

The Quetta epidemic of 1898 was attributed to dust infection for the following reasons:-

- (1) Immunity till May when dust storms began.
- (2) Dust storms prevailed from May 2nd to 13th.
- (3) Filth pits were windward of the Barracks and the epidemic was especially severe in the lines nearest the filth pits.

Firth and Horrocks shewed that infected dry soil blown about as dust, was capable of infecting distant objects after 24 days from the time of dessication.

The Bacillus is said by Heim⁹ to withstand drying/

drying for at least 213 days.

In the official Report on the spread of Typhoid in the U.S. camp in the Spanish War of 1898 the opinion was expressed that diffusion by flies and dust was a most probable cause of infection.

Firth and Horrocks recovered the bacillus from air dried fabrics as Khaki drill and serge after 74 - 84 days.

Though difficult to believe that a non-sporing organism of comparatively delicate sort can remain dormant for long periods in the form of dust, still the possibility of excreta, particles of soil and fluff of soiled linen, when the specific contamination is recent, infecting food and drink in the form of dust cannot be denied.

FLIES. Both in the Spanish American War, and in the South African campaign,¹⁰ reports dealing with the spread of Typhoid laid stress on flies as one of the chief means of spreading the disease.

Colonel Quill in his report on the outbreak of Enteric in Diyatalawa, Ceylon, in 1900, shewed that the immigration of flies from the infected Boer camp to that occupied by the Troops was easy. Enteric Fever is especially prevalent where the dry earth system prevails - where flies have an opportunity of crawling on faeces.

Celli/

Celli ¹¹ in 1888 shewed that flies bred on pure cultures of B. Typhosus were able to transmit bacilli in their excrement, and inoculations shewed that the bacilli were virulent.

From flies caught on two undrained privies, on the fences of two years, and on the walls of two houses and in the room of an enteric patient, Hamilton ¹³ in 18 experiments recovered the bacillus five times.

Recent investigations on the pollution of the New York harbour ¹³ has shewn that the common house fly is capable of carrying 100,000 faecal bacteria on its legs and mouth parts.

INFECTION BY CONTACT. The recent work of Koch and his followers to suppress the disease in certain parts of Germany go to prove that the human host must be regarded as the chief source of infection, the specific virus being conveyed in the faeces and urine, also to some extent probably in vomit, sputum and saliva. Clothes, bedding, furniture, food, utensils soiled by these cases may readily convey infection to others.

Contact infection may be (1) immediate or direct from the body of the patient to his attendants or (2) mediate or indirect, through the medium of articles soiled by patients.

In/

In England the fact of the contagiousness of the disease has been proved chiefly through the writings of Goodall,¹⁴ Bulstrode,¹⁵ and Newman¹⁶

A flood of light has recently been thrown on the etiology of the disease by the discovery of "Typhoid Carriers" and the recognition of the danger to the community of convalescents and those suffering from the abortive and often unrecognised forms of the disease.

Horton Smith,¹⁷ in his Goulstonian Lectures, gives the percentage of infective convalescents as about 25% - i.e. those passing Typhoid Bacilli in their urine. The German Commission¹⁸ found the bacilli not only in the stools of convalescents, but in stools and urine of people who gave no history of previous attacks of Enteric Fever, and especially in those who had been in contact with Typhoid patients.

Horton Smith states that the duration of the specific bacilluria varies from 8 to 70 days, and may be as long as five years. Other observers record cases where the Bacillus persisted in the urine for seven years after the attack.

The work of German Hygienists, especially Klinger and Kayser, has proved how fertile a source of danger to the community is the Typhoid carrier.

It/

It was shewn that altogether 1.7% of Typhoid patients became chronic carriers. Klinger¹⁷ does not regard the acute Typhoid carrier - those people who had been closely associated with Typhoid patients, and who were found to pass Typhoid Bacilli in their stools for a short time only - as so dangerous as the chronic or persistent carriers.

It has been shewn that in these cases the bacilli vegetate in the gall-bladder, from which they are intermittently thrown into the intestine.

In a recent paper²⁰ on an outbreak of Enteric Fever in an Asylum in Scotland, Drs. A. and J.C.G. Ledingham report the discovery of three Typhoid carriers out of a total of 90 female patients examined. One of these had had an attack of Typhoid Fever 13 years previous, and in the other no history of Typhoid could be obtained.

Dean²¹ reports a case of a Typhoid carrier of 29 years standing.

The recognition of these Typhoid carriers suggests a clue to the causation of many isolated cases of the disease for which no satisfactory explanation could be obtained, and is of vital importance from the point of view of preventive medicine. When these carriers are in any way connected with the food supply it has been proved that/

that they may act as distributors of disease to many individuals.

Children, moreover, may be dangerous to the community, especially when the liability of children to soil their surroundings is recognised. It has been shewn that frequently the disease appears in them as a feverish dyspepsia and passes unrecognised.

Conradi²² states that the great incidence of Typhoid among children was chiefly responsible for the endemic prevalence of the disease in Metz. Though the Malabar Tamil coolies are supposed to have acquired a certain degree of immunity by continued residence in the endemic area, still the experience of medical men in Ceylon shews how common the disease is amongst children of the Singhalese and other native races.

MILK. Milk may convey the infection by being contaminated by dirty water used for washing the utensils. The sight of a native milkman washing out his bottles and cans in the most convenient roadside stream is only too common.

Milk after sterilisation may further be contaminated by dust and flies, and in dairies the contamination by the hands of those who have attended on the sick must not be forgotten. With the great majority of native patients who do not use milk as an article of diet, this source of infection can be ignored.

INFECTION BY UNCOOKED VEGETABLES. It is recognised that there is a real danger in eating raw vegetables such as water-cress, lettuce and celery, if these have been exposed to sewage contamination.

Houston ²³ however asserts that such vegetables are rendered innocuous if carefully washed.

I have frequently seen, and reported to the sanitary authorities, native vegetable dealers washing their produce in the open natural drains about the town, and the danger of this practice must be recognised in view of the fact that Nuwera Eliya largely supplies the Colombo market with "English" vegetables.

The most important problem to be faced as regards the etiology of Typhoid in the Tropics is the method of sewage disposal. Enteric Fever is most prevalent where the 'dry earth' system prevails, with superficial burial of the dejecta. This danger is aggravated by the careless habits of the natives to whom latrines and urinals are a superfluity.

Adults, and more particularly children, relieve themselves on the floor to save themselves the exertion of mounting the 'squatting' plate. Urine in the latrines is invariably voided on the floor and finds its way into the soil. During transit to the trenches leakage from the buckets is not at all uncommon, /

uncommon, and as there is no disinfection of the excreta, infection can be conveyed by flies and dust from droppings on the road.

In the Leicester Epidemic of 1894 one street shewed five times as many infected houses among those using the tub system as amongst those having water-closets and sewers. In Nottingham during 10 years 1887 - 1896, the incidence was one case for every 120 houses having the pail system, an one for every 558 houses having water-closets.²⁴

In Bermuda Barracks the dry earth system was gradually replaced by water carriage, commencing in 1897, a few latrines remaining in 1903 with the following results:-

ADMISSION RATE per 1000 for ENTERIC

1888 - 1897	34.8
1898 - 1905	16.3

ENTERIC FEVER is comparatively rare in native villages where there is no system of conservancy, but where the villagers perform the offices of nature on the open ground. The excreta are brought under the direct influence of the sun's rays and as has been proved by Firth and Horrocks the Typhoid Bacillus is sensitive to isolation, and is not known to resist solar heat for longer than 122 hours. Having reviewed our knowledge of the bacteriology of the/

the disease, and discussed the chief etiological factors, I shall now turn to my personal experiences of the epidemic, which is the subject of my report.

The first case was discovered in the native quarter of the Town, known as the Old Bazaar. The most careful enquiries failed to throw any light on the source of infection. The epidemic was practically confined to two localities and tended to spread in families living in tenements under the same roof, and in neighbouring streets, where overcrowding, want of air space, drain nuisances, and a general want of cleanliness prevailed, and where the conditions were favourable to a serious pollution of the soil.

In Hawa Eliya with a population of over 150 there was not a single public latrine, and no drains of any description. The floors of these dwellings in the infected quarter, were generally of earth beaten down, and the walls of 'wattle and daub,' broken, uneven, and unplastered. The presence of faecal matter in the yards and vegetable gardens attached to these native houses, gave ample proof that the soil has been polluted for years with urine, faeces and sewage, and the presence of swarms of flies was unpleasantly in evidence.

The/

The Hospital records shew that in no year has the town been free of sporadic cases of Typhoid Fever in the native quarter and in the light of our present knowledge it is not difficult to explain the tenacity of the infection in endemically infected areas.

The town of Nuwera Eliya largely supplies both the local and Colombo market with English vegetables, and the question has been raised whether the presence of the extensive, highly manured vegetable gardens in the heart of the town constitutes a danger. Cattle dung is invariably used as manure, and in no instance is human excreta used as a fertiliser. In the quarter where Typhoid occurred there were extensive vegetable gardens in close proximity, two of them bordering on Public Latrines.

Apart from the usual native practice of defaecating and urinating in the open ground, it is not unusual to find the stools of a sick person, which has been passed on to a layer of sand on a mat, deposited on the soil of the adjoining back yard. Here the danger of infection through flies and dust arises, the numerous rubbish and manure heaps affording suitable breeding places for flies.

Moreover, the numerous mountain streams flowing/

flowing through these gardens are often used for bathing purposes and the washing of clothes, and thus infection can be readily derived, if at any time the discharge of a Typhoid patient have been carelessly thrown into a native market garden.

It is a common experience that Typhoid Fever in India is relatively more prevalent in hot and dry seasons. The failure of the South West Monsoon rains in 1905, followed by a prolonged drought extending into the present year (1906) and threatening a failure of the water supply, was a noticeable feature. The unusually dry season brought in its train the dust and fly nuisance, and the trying climatic conditions may have further tended to produce a lowering of the natural resistive powers of the body.

It is not possible to give the history or attempt to trace the source of infection of every case which came under my notice. I propose to quote a few cases to illustrate the probable means by which the disease was contracted.

In the year 1904 the daughter of a dairyman suffered from Typhoid Fever. Early in the year his son contracted the disease. The 'night soil' including the discharges of the patients, was buried in the grounds of the dairy, which was not supplied with/

with the town water. Water for washing the milk cans and bottles, it was discovered, was derived from a stream flowing through the grounds. The mother of the patient, on whom she was in constant attendance, supervised the work of the dairy, and it is moreover possible that she may have conveyed infection to the milk. Four cases occurred in the English family supplied with milk from the dairy, and an English lady visitor, who had been to tea with the family, also contracted the disease. Enquiry shewed that the milk was never boiled. Three months after the apparent recovery of the dairyman's child, the English Banker, supplied with milk from this dairy, sickened with Typhoid Fever. Though customers were warned against this dairy, it is more than regrettable that its compulsory closure was not insisted on by the local Board of Health, until the mischief was done. No further cases occurred among the European residents whose houses were at a distance from the native town.

It is noteworthy that many of the cases of Typhoid in the old Bazaar occurred in tenements, the open natural drains facing which, were fed by divertations of the stream which I have referred to as flowing through the grounds of the infected dairy./

dairy. In these drains I have seen cooking utensils, plates, and clothes being washed.

The daughter of a native confectioner, who had been warned against this practice, developed the disease, and a customer, the son of the native curate, also suffered from an attack of Typhoid. In the case of native patients who rarely use milk, I was able to exclude milk as a source of infection. In some instances I found that condensed milk had been used, and the danger of infection of an opened tin of milk left lying unprotected from flies and dust has to be considered.

Two cases of Typhoid occurred among the prisoners in the jail. The patients confessed to having, when out with a working party, drank the water of a stream flowing past the Bazaar. The excreta of these two patients, previous to their removal to Hospital, was buried outside the jail, disinfection having probably been carelessly carried out.

A stream which flowed past the jail, through a swamp, and past Model Dwellings, No.2, was liable to pollution by the drainage from the night soil trenches of the jail. A child from Model Dwellings No.2, a mother and four children from Model Dwellings/

Dwellings No.1 - half a mile away - who suffered from Typhoid Fever, were found to have bathed in this stream, the water of which they also drank. Bathing in this stream was prohibited, and no fresh cases occurred in the adjoining dwellings.

A case occurred in the Hawa Eliya Bazaars. The patient was frequently visited during her illness by her sister, the wife of the Park Keeper, and by her brother, a servant of the Brewer. Both contracted the disease, and as they lived under good sanitary conditions, the infection in their cases was probably through personal contact, or through food eaten in the infected house.

The excreta of this case in Hawa Eliya was buried in, or more probably thrown into the garden adjoining the house, in which was a small pond. Two months after, three children of a family occupying a hut below developed Typhoid Fever. Though there was an abundant supply of pure town water, enquires proved that these children had frequently bathed in the pond, on the closure of which no further cases occurred in this locality.

In the house occupied by the caretaker of the Race Course, a mile away from the Bazaar, two children were found to be suffering from Typhoid. The house was supplied with the Town water, the general/

general sanitary conditions were good, milk had never been used as an article of diet, and the usual sources of infection could be eliminated. However, the father of the patients had frequently visited the infected area in the old Bazaar, where in the house of his sister, five cases had occurred. This woman was the keeper of a native lodging house, and during the course of two months, with intervals of two to three weeks between, five of her lodgers developed the disease, she herself being the last to sicken.

Two cases occurred in a house across the street occupied by a native Government Clerk, a highly educated man, of good social standing and possessed of a "sanitary conscience." Every other source of infection could be excluded and the alternative lay between infection through dust or flies, or through contact, as the mother of the patients confessed to having, from charitable motives, visited the sick in the lodging house.

Three cases occurred in a native hut, a few feet removed from a Public Latrine, used by people living in the infected area in the old Bazaar. The presence of swarms of flies, feeding on droppings on the floor of the Latrine left no doubt as to the most probable source of infection. This latrine was/

was used by the pupils of a native school close by, one of whom, living in an isolated Tea Garden, three miles away from Town, where there had been no other cases, contracted Typhoid Fever.

In the case of a lady visitor from Colombo, who in apprehension of contracting the disease, had taken every precaution, even to the length of bringing up her own cow, the infection was probably derived from water-cress, gathered by her in the streams in the Park. She confessed to an inordinate fondness for water-cress. Three cases were reported in the house of an Eurasian family, situated almost opposite to the premises of the dairy I have referred to. Three members of this family, educated, intelligent persons, of good social standing, had taken every precaution to guard against the disease, living as they did in the infected area. Their house and premises were scrupulously clean, and the most probable source of infection was through flies and dust.

PROPHYLAXIS. In order to combat the spread of the disease, all "native medicine men" were warned to report all cases of Fever of a ^{character} continued of more than three days duration.

As is well known the native Doctor neither recognises/

recognises the specific nature of the disease, nor its infectious character. All cases of continued fever, malaria, pneumonia, or true enteric, accompanied with delirium, are diagnosed as "Sanni," the equivalent of Typhoid Fever.

In the native quarters, weekly house to house inspections were made by the Sanitary Officer, with the object of enforcing sanitary regulations, and detecting cases of the disease, With the exception of a comparatively few cases, all cases of the disease were removed to Hospital, in the face often of much opposition offered by patients and their friends. In Hospital the diagnosis in all cases was confirmed by Widal's reaction.

Circulars were distributed warning residents and visitors to the Sanitarium of the danger of eating water cress, lettuce, celery etc., from native gardens, and insisting on the necessity of boiling their milk, and protecting their food from flies.

All dairies were frequently and carefully inspected. The infected dwellings, furniture, clothes etc., were effectively disinfected. Special attention was paid to the condition of the Public and private latrines. All rubbish in native gardens/

gardens was regularly burnt. Hitherto a Public Latrine was supposed to look after itself, but on my recommendation a cooly, to be in constant attendance, was placed in charge of each latrine, and held responsible for its cleanliness.

It is not probable that the town with its 4000 inhabitants will be able to meet the expense of substituting other methods of sewage disposal for the dry earth system now in use. It is therefore necessary to ensure that the present methods are as little objectionable as possible. Latrines, Urinals and their vicinity may be regarded as probably infected.

An abundant supply of disinfectants for the disinfection of all excreta from infected cases was provided at the public expense, as well as for the disinfection of private latrines.

For the future I would recommend the use of 3% solution of crude carbolic acid in the pans instead of dry earth. Experience in India has shewn that though this does not disinfect the excreta, the fly nuisance is abated. It is further essential that the pails should fit close under the seat, which if possible might be provided with an automatically closing lid, or fly proof screen.

Householders/

Householders, especially in the native quarters, should not be permitted to erect latrines unless these conform to a plan of Latrine - with impermeable floor and sides, and with provision for the prevention of urine and ablution water finding their way into the soil, approved of by the Local Board of Health.

Additional Public Latrines are needed, especially in Hawa Eliya Bazaars, where, with a native population of 150, there is not a single latrine.

The Board of Health has considered the advisability of abolishing the large vegetable gardens in the heart of the Town. Apart from the fly nuisance occasioned by the presence of heaps of manure and organic refuse in these gardens, I fail to see how they can constitute a danger, if, by improvement in the drainage and methods of sewage disposal, the excreta of infected persons is prevented from reaching the soil. As regards the prevention of the fly nuisance, the addition of Chloride of Lime on a dung heap may act as an insecticide, and dung spread as manure on gardens should be immediately covered with a layer of dry earth. Stricter supervision of stables, cow-sheds and goat pens is also necessary, and the bye-laws prohibiting/

prohibiting the stacking of cow-dung or horse-dung, in the premises in the town, for over 24 hours should be rigidly enforced.

Early diagnosis and the segregation of cases is important, as also the recognition of mild and abortive cases. It is advisable to treat every case of continued fever as enteric, until the diagnosis can be confirmed, and to adopt early measures for the disinfection of all stools, urine and sputum.

Many cases of enteric in the Tropics are so mild and atypical that the diagnosis is often never made and these unrecognised cases are a fruitful source of danger. The Widal reaction cannot unfortunately be requisitioned until after the first week of the disease, and methods of diagnosis by blood cultures is not possible in up-country stations in the absence of laboratories.

Where possible, especially in Hospital cases, before discharge, Urotropine should be systematically administered to combat the Typhoid Bacilluria. Unfortunately this remedy is futile in the treatment of Typhoid carriers who pass the bacilli in their faeces. The detection of these Typhoid carriers and their treatment is obviously difficult especially in the case of ignorant natives, and in the absence of/

of facilities for bacteriological work.

The path leading past the Reservoir of the water works to the jungle behind should be closed. There is undoubtedly a risk of native firewood gatherers polluting the mountain streams feeding the Reservoir and it is appalling to contemplate the mischief which might be done by a Typhoid carrier. Public bathing places, supplied with the Town water should be provided and bathing and the washing of clothes in the streams of the Town should be prohibited.

The drainage of the Town demands immediate attention. Some of the native quarters are absolutely devoid of drains. Many drains, stinking vilely, pass along the sides of eating houses, native shops, and bazaars. The present obsolete rectangular drains, which are not self-cleansing in small flows and difficult to flush, should be replaced by the more modern peg-top shaped drain.

The conclusions I have arrived at as regards the endemic prevalence of Typhoid in N. Eliya and the occurrence of the present epidemic, are

- (1) That the water supply cannot be incriminated.

Its source is such that contamination is highly improbable, and repeated analysis has proved its purity/

purity. Further the occurrence of isolated cases separated by intervals of weeks or days was in contrast to the explosive outbreaks characteristic of infection from the water supply.

- (2) That infection by contact was responsible for a large number of cases.
- (3) That infection was, in many instances, spread in an unusually hot, dry season by dust and flies.
- (4) That there is a universal pollution of the soil of the Bazaars, and the contamination of the streams.
- (5) That apart from the cases where the infection was traced to one dairy, milk as a source of infection can be disregarded.

The following table shews the relation of the rainfall to the number of cases of Enteric Fever, Diarrhoea and Dysentery, treated in Hospital. It is noticeable that with the onset of the South West Monsoon rains in the beginning of June, there was a fall in the number of admissions. The heavy rains would have the effect of purifying the soil, by causing the disappearance of pathogenic organisms from its surface layers, of flushing the drains, and causing/

causing the abatement of the dust and fly nuisance.

1906	ENTERIC	DIARRHOEA and DYSENTERY.	RAINFALL Inches.
January - March	15	84	7.06
April - June	16	110	15.83
July - September	11	76	25.75
October - December	5	72	46.65

REFERENCES.

- (1) Spectator. September 1905.
 - (2) Archiv. fur Hygiene quoted in Annual Report of Sanitary Commissioner for India. 1904.
 - (3) Hygienische Rundschau XIV.
 - (4) British Medical Journal 1898.
 - (5) Firth & Horrocks - ibid. 1902.
 - (6) Houston. Report to Local Government Board 1901 - 1902.
 - (7) Mair. Journal of Hygiene. Vol.VIII No.1 (1908)
 - (8) British Medical Journal. August 1901.
 - (9) Zeitschrift fur Hygiene Bd.50 1905.
 - (10) British Medical Journal 1902.
 - (11) Nuttall. Role of insects etc., in spread of Disease
 - (12) John Hopkins Hospital Reports. Vol. VII.
 - (13) British Medical Journal, January 1908.
 - (14) Transactions of Epidemiological Society. Vol. XIX.
 - (15) Local Government Board Report 1902.
 - (16) Practitioner. January 1904.
 - (17) Lancet 1900.
 - (18) Journal Royal Army Medical Corps. Vol. VI.
 - (19) Quoted in B. M. J. January 1908.
 - (20) British Medical Journal. January 1908.
 - (21) British Medical Journal. March 1908.
 - (22) Annual Report. Sanitary Commissioner for India 1905.
 - (23) British Medical Journal. April 1908.
 - (24) Munson's Military Hygiene.
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